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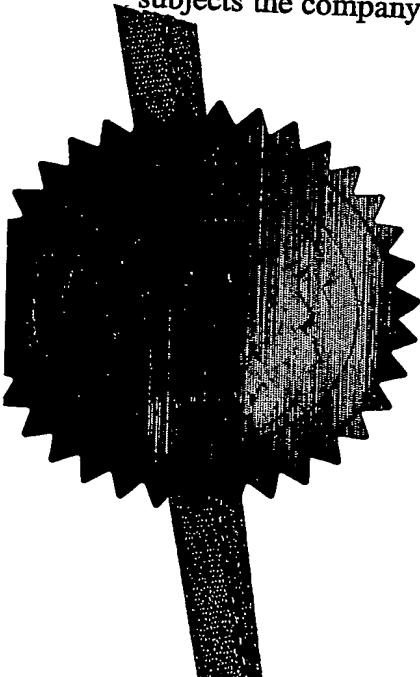
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1. Your reference

2834.uk

2. Patent application number

(The Patent Office will fill in this part)

0307521.5

- 1 APR 2003

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Specialised Petroleum Services Group Limited
Wellbore Completion Services
Arnhall Business Park
Westhill
ABERDEEN
AB32 6TQ

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

United Kingdom

8460784001

4. Title of the invention

Downhole Tool

5. Name of your agent (if you have one)

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

Kennedys Patent Agency Limited
Queens House, Floor 5
29 St Vincent Place
GLASGOW
G1 2DT

Patents ADP number (if you know it)

08058240002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

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7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

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8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if)

Yes

- a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or

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Continuation sheets of this form	--
Description	13
Claim(s)	--
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Priority documents	--
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I/We request the grant of a patent on the basis of this application.

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12. Name and daytime telephone number of person to contact in the United Kingdom

David Kennedy - 0141 226 6826

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1 **Downhole Tool**

2

3 The present invention relates to apparatus and a method
4 for circulating fluid in a borehole.

5

6 It is common practice to install liners within a borehole
7 which has been drilled. After installation of the liners
8 it is generally necessary to clean out the inside of the
9 liner to wash away any debris or other contaminants.

10

11 Generally, the liner is in the form of a cylindrical tube
12 which has a relatively small internal diameter compared
13 with the diameter of casing lining the borehole
14 immediately above the liner. To effectively clean out the
15 inside of the liner, high flow velocities are generally
16 required to create turbulence to aid the cleaning out
17 process. Generally, the clean out procedure is carried
18 out by first passing cleaning liquid through the work
19 string inserted into the liner, to exit from the work
20 string at the lower end of the liner at a high flow rate
21 so that the cleaning fluid flows turbulently up the
22 annulus between the inside of the liner and the outside
23 of the work string and then into the casing above the

1 liner.

2

3 Generally, the work string is made up of a number of
4 lengths of drill pipe, or other tubulars, threadedly
5 connected together to form the work string, which may
6 also be referred to as the drill string.

7

8 However, because of the difference in volume between the
9 liner and the casing above the liner, after the cleaning
10 fluid passes the top of the liner and enters the
11 relatively large volume of the casing, the flow velocity
12 of the cleaning fluid in the casing above the liner is
13 greatly reduced and any cleaning action becomes
14 negligible.

15

16 Hence, it is generally necessary after passing cleaning
17 fluid through the liner to then pass further cleaning
18 fluid from the work string into the casing at a location
19 above or adjacent the top edge of the liner, so that a
20 high flow rate and hence turbulence of the cleaning fluid
21 can be obtained in the casing. Therefore, it is generally
22 necessary to have some device at or adjacent to the top
23 end of the liner which can be operated downhole to either
24 circulate fluid through the length of the work string to
25 the lower end of the liner or which can direct cleaning
26 fluid at high flow rates out of the work string onto an
27 inner surface of a casing or liner.

28

29 Circulation tools have thus been developed to redirect
30 fluid flow through the work string radially outward of
31 the tool, to impact the inner wall of the casing or
32 liner. By making the radial exit ports small, fluid
33 velocity is increased at these locations, thus improving

1 cleaning. Various methods have also been developed to
2 control the exit of fluid from the radial ports and
3 provide a tool with selectable operation.
4

5 One such circulation tool is that disclosed in US
6 4,889,199. This tool comprises tubular casing means for
7 mounting in a drill string; first outlet means in said
8 casing means for discharging fluid from said casing
9 means; sleeve means slidably mounted in said casing
10 means; spring means in said casing means biasing said
11 sleeve means to a closed position in which said sleeve
12 means closes said first outlet means; second outlet means
13 in said sleeve means for discharging fluid from said
14 sleeve means when said first and second outlet means are
15 aligned; a ball, retainer means in said sleeve means for
16 releasably retaining said ball for preventing flow of
17 drilling fluid through said sleeve means and causing said
18 sleeve means to move relative to said casing means into
19 an open position in which said first and second outlet
20 means are aligned to discharge fluid through said casing
21 means, a second ball for blocking said second outlet
22 means so that pressure on said first and second balls
23 increases sufficiently to drive said first ball through
24 said sleeve means for restoring the normal flow of
25 drilling fluid through said sleeve means and for allowing
26 the return of said sleeve means to said closed position.
27

28 A disadvantage of this tool is that it requires both a
29 deformable ball and a smaller metal ball to operate. Care
30 must then be taken to ensure the balls are dropped in the
31 correct order. The smaller metal ball must lodge in the
32 second, radial, outlet in order to stop flow and thus the
33 tool is restricted to having a single radial port. This

1 limits the amount of cleaning which can be performed. Yet
2 further is a disadvantage in that when the tool is in the
3 open configuration, fluid flow is against the seals
4 between the sleeve and casing causing increased wear and
5 potential failure.

6

7 It is thus an object of the present invention to provide
8 a downhole tool for circulating fluid in a borehole which
9 can be operated using a uniform drop ball.

10

11 It is a further object of at least one embodiment of the
12 present invention to provide a downhole tool for
13 circulating fluid in a borehole which includes a
14 plurality of radial ports and is operated by a drop ball.

15

16 According to a first aspect of the present invention
17 there is provided a downhole tool for circulating fluid
18 in a borehole, the tool comprising tubular casing means
19 for mounting in a work string; first outlet means in said
20 casing means for discharging fluid from said casing
21 means; sleeve means slidably mounted in said casing
22 means; second outlet means in said sleeve means for
23 discharging fluid from said sleeve means when said first
24 and second outlet means are aligned; engagement means to
25 control relative movement between said sleeve means and
26 said casing means; spring means biasing said sleeve means
27 against said engagement means; a ball; retainer means in
28 said sleeve means for releasably retaining said ball for
29 preventing flow of fluid through said sleeve means and
30 causing said sleeve means to move relative to said casing
31 means as determined by said engagement means.

1

2 Preferably the ball is deformable. In this way the ball
3 can be released and the tool re-used in the borehole.

4

5 Preferably also the tool includes ball collecting means.
6 The ball collecting means may be an element located in
7 the casing means to prevent passage of the ball through
8 the tool, but allowing passage of fluid through the tool.

9

10 Preferably said outlet means are radial ports located
11 substantially perpendicular to a longitudinal axis
12 through the tool. More preferably there are a plurality
13 of said first and said second outlets. Advantageously
14 there are three or more said first and said second
15 outlets. Preferably also said first and said second
16 outlets are spaced equidistantly around the casing means
17 and sleeve means respectively.

18

19 Preferably said engagement means comprises at least one
20 index pin located in a profiled groove. Preferably the at
21 least one index pin is located on the casing means and
22 the profiled groove is located on an outer surface of the
23 sleeve means. In this way, an index sleeve is produced
24 with the groove determining the relative position of the
25 sleeve means to the casing means. Advantageously the
26 groove extends circumferentially around the sleeve means,
27 thus the tool can be continuously cycled.

28

29 Preferably the retainer means is a ledge or shoulder
30 located on an inner surface of the sleeve means. The ball
31 therefore rests on the shoulder until sufficient pressure
32 builds up to force the ball passed the shoulder.

33

1 Preferably also the spring means is located in a chamber
2 created between the sleeve means and the casing means.
3 Advantageously the chamber includes an exhaust port such
4 that fluid can enter and be dispelled from the chamber by
5 relative movement of the sleeve means and the casing
6 means.

7
8 According to a second aspect of the present invention
9 there is provided a method of circulating fluid in a
10 borehole, the method comprising the steps:

- 11
12 (a) inserting in a work string a tool comprising a
13 tubular casing including a plurality of first radial
14 outlet ports in which is located a sleeve including
15 a plurality of second radial outlets and an
16 engagement mechanism for moving the sleeve relative
17 to the casing;
18 (b) running the work string and tool into a borehole,
19 with the sleeve in a first position relative to the
20 casing wherein the first and second radial outlets
21 are misaligned and fluid flow is through the work
22 string;
23 (c) dropping a ball into the work string such that the
24 ball lands on the sleeve and forces the sleeve into
25 a second position relative to the casing wherein the
26 first and second radial outlets are misaligned and
27 fluid flow is through the work string; and
28 (d) increasing pressure behind the ball to deform the
29 ball and force it through the sleeve, the releasing
30 pressure allowing the sleeve to move to a third
31 position relative to the casing wherein the first
32 and second radial outlets are aligned and fluid
33 flows through the radial outlets.

1

2 Preferably the method further includes the steps of:

3

4 (e) dropping a second ball, identical to the first ball,
5 into the work string such that the second ball lands
6 on the sleeve and forces the sleeve into the second
7 position relative to the casing wherein the first
8 and second radial outlets are misaligned and fluid
9 flow is through the work string; and

10 (f) increasing pressure behind the second ball to deform
11 the second ball and force it through the sleeve, the
12 releasing pressure allowing the sleeve to move to
13 the first position relative to the casing wherein
14 the first and second radial outlets are misaligned
15 and fluid flows through the radial outlets.

16

17 With the sleeve and casing back in the first position,
18 the steps (c) to (f) can be repeated any number of times.

19

20 Preferably also the method includes the step of catching
21 the dropped balls in the work string.

22

23 An embodiment of the present invention will now be
24 described by way of example only with reference to the
25 following Figures, of which:

26

27 Figure 1 is a part cross-sectional view of a downhole
28 tool in a first position according to an embodiment of
29 the present invention;

30

31 Figure 2 is a part cross-sectional view of the downhole
32 tool of Figure 1 in a second position;

33

1 Figure 3 is a part cross-sectional view of the downhole
2 tool of Figure 1 in a third position; and

3

4 Figures 4(a)-(c) are schematic illustrations of an index
5 pin positioned in a groove of the tool of Figure 1 for
6 the first, second and third positions respectively.

7

8 Reference is initially made to Figure 1 of the drawings
9 which illustrates a downhole tool, generally indicated by
10 reference numeral 10, in accordance with an embodiment of
11 the present invention. Tool 10 includes a cylindrical
12 body 12 having an upper end 14, a lower end 16 and a
13 cylindrical bore 18 running therethrough. The body 12 has
14 a box section 20 located at the upper end 14 and a pin
15 section 22 located at the lower end 16 for connecting the
16 tool 10 in a work string or drill string (not shown).

17

18 The body 12 further includes four radial ports 24 located
19 equidistantly around the body 12. The ports 24 are
20 perpendicular to the bore 18.

21

22 Located on an inner surface 26 of the body 12 are two
23 opposing ledges 26, 28 used to limit axial movement of a
24 sleeve 30 located within the body 12. Sleeve 30 is sealed
25 against body 12 by o-rings 31a-d.

26

27 Sleeve 30 is an annular body which also includes four
28 radial ports 32 located equidistantly around the sleeve
29 30. The ports 32 are perpendicular to the bore 18. The
30 ports 32 are of a similar size to the ports 24 in the
31 body 12.

32

1 A ball seat 34 is located on the sleeve 30 at an upper
2 end 36. The ball seat comprises a conical surface 38
3 facing the upper end 14 of the tool 10. A throat 40 is
4 provided at a base of the conical surface 38, the throat
5 having a diameter less than the diameter of the bore 42
6 of the sleeve 30.

7

8 Located between the outer surface 44 of the sleeve 30 and
9 the inner surface 46 of the body 12 is a space forming a
10 chamber 48. The upper edge of the chamber is formed from
11 a ledge 50 on the outer surface 44 of the sleeve 30. The
12 lower edge of the chamber 48 is formed from the ledge 28
13 of the body 12. A strong spring 52 is positioned within
14 the chamber 48 and compressed to bias against the ledge
15 50 of the sleeve 30. An exhaust port 54 is located
16 through the sleeve 30 at the chamber 48 to allow fluid
17 from the bore 42 to pass in to and out of the chamber 48
18 as the sleeve 30 is moved relative to the body 12.

19

20 Further an engagement mechanism, generally indicated by
21 reference numeral 56, couples the sleeve 30 to the body
22 12 and controls relative movement there between.

23 Engagement mechanism 56 comprises an index sleeve 58,
24 being a portion of the sleeve 30, and a matching index
25 pin 60 located through the body 12 towards the sleeve 30.
26 Index sleeve 58 includes a profiled groove 62 on the
27 outer surface 44 of the sleeve 30 into which the index
28 pin 60 locates.

29

30 Reference is now made to Figure 4 of the drawings which
31 illustrates the groove 62 of the index sleeve 58. The
32 groove 62 extends circumferentially around the sleeve 30
33 in a continuous path. The groove 62 defines a path having

1 a substantially zig-zag profile to provided axial
2 movement of the sleeve 30 relative to the body 12.
3 Indeed, spring 52 biases the sleeve 30 against the index
4 pin 60. The path includes an extended longitudinal
5 portion 64 at every second upper apex of the zig-zag.
6 Further a stop 66 is located at the apexes of the zig-
7 zags to encourage the index pin 60 to remain at the
8 apexes and provide a locking function to the tool 10. The
9 stops 66 are in the direction of travel of the pin 60
10 along the groove 62.

11
12 Reference is now made to Figure 2 of the drawings which
13 illustrates the tool 10 of Figure 1, now with a ball 68
14 located in the bore 42. Like parts to those of Figure 1
15 have been given the same reference numeral for ease of
16 identification. Ball 68 is sized to rest on surface 38
17 and be of a deformable material e.g. rubber so that under
18 force it can pass through the throat 40.

19
20 Reference is now made to Figure 3 of the drawings which
21 illustrates the tool 10 of Figure 1, now with the ball 68
22 exiting the sleeve 30 into the bore 18. Like parts to
23 those of Figures 1 and 2 have been given the same
24 reference numeral for ease of identification. Body 12
25 includes a pin 70 located into the bore 18. Pin 70 is a
26 ball retainer pin which blocks the passage of the ball 68
27 through the bore 18. Ball 68 will come to rest at the pin
28 70 and therefore be retrievable with the tool 10. Pin 70
29 does not prevent the flow of fluid through the bore 18
30 and from the tool 10 into the work string below. The pin
31 70 and the space 72 in the bore 18 immediately above it
32 may be considered as a ball catcher.

33

1 In use, tool 10 is connected to a work string using the
2 box section 20 and the pin section 22. As shown in
3 Figures 1 and 4(a), the spring 52 biases the sleeve 30
4 against the index pin 60 such that the pin 60 is located
5 in the base apex of the groove 62. This is referred to as
6 the first position of the tool 10. In this position,
7 sleeve ports 32 are located above body ports 24, thus
8 preventing fluid flow radially through these ports due to
9 their misalignment. All fluid flow is through bores 18,42
10 of the tool 10. The tool 10 is then run into a bore hole
11 until it reaches a location where cleaning of the bore
12 hole casing or circulation of the fluid through the tool
13 is required.

14
15 Drop ball 68 is then released through the bore of the
16 work string from a surface. Ball 68 travels by fluid
17 pressure to the ball seat 36 of the sleeve 30. The ball
18 68 rests on the conical surface 38 and prevents axial
19 fluid flow through the tool 10. Consequently fluid
20 pressure builds up behind the ball 68 and the sleeve 30,
21 including the ball 68, moves against the bias of the
22 spring 52, to a second position. This position is
23 illustrated in Figure 2 and 4(b). The spring 52 is
24 compressed into a now smaller chamber 48. Fluid has been
25 expelled from the chamber 48 through the exhaust port 54.
26 The index pin 60 is now located at the top of the
27 longitudinal portion 64 of the groove 62. Consequently
28 the sleeve ports 32 have crossed the body ports 24 and
29 are now located below them. Fluid flow is thus still
30 entirely through the bores 18,42.

31
32 As pressure increases on the ball 68 it is extruded
33 through the throat 40 by deforming. The ball 68 travels

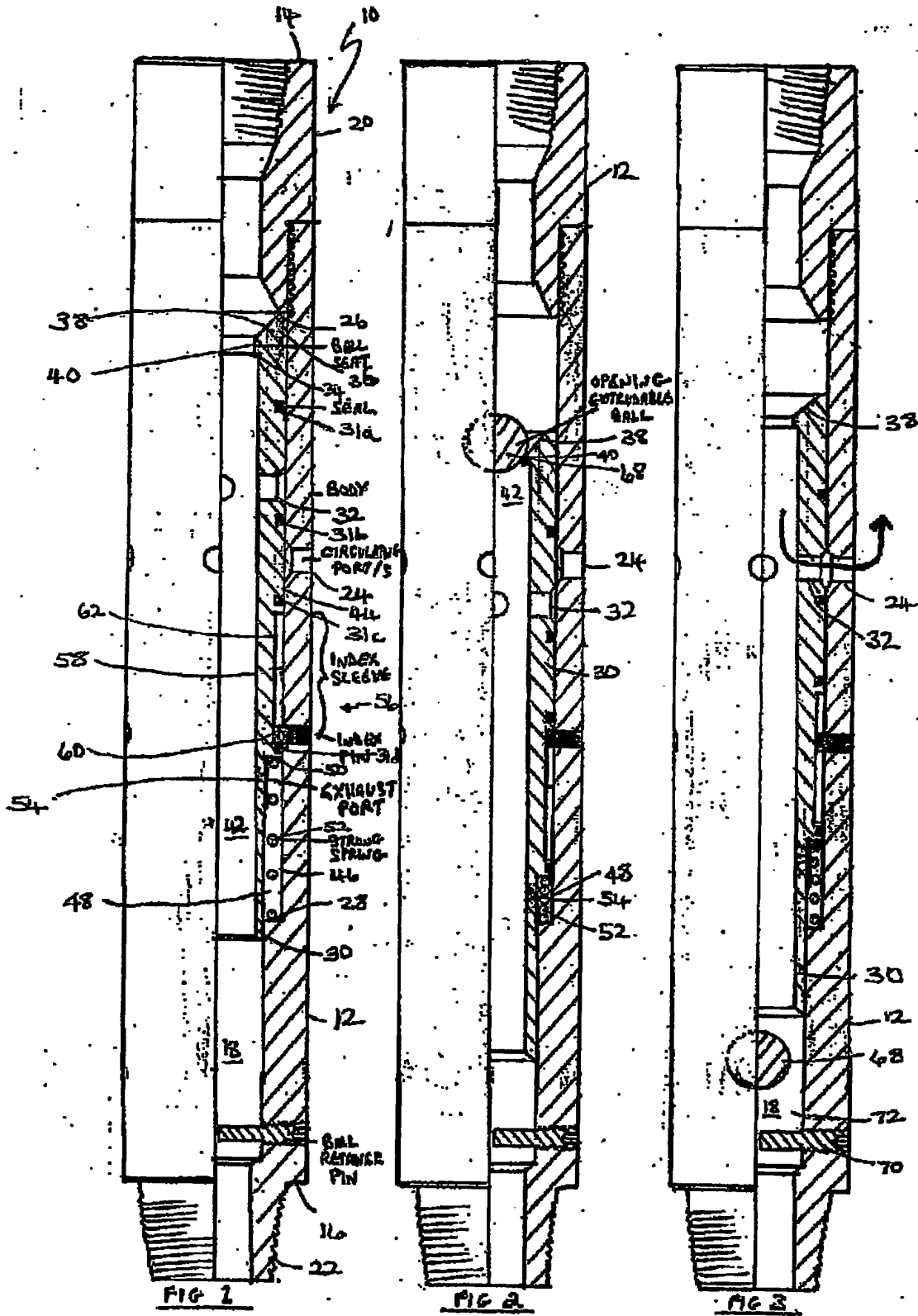
1 by fluid pressure until it is stopped by the pin 70 and
2 is held in the space 72. On release of the pressure,
3 spring 52 moves the sleeve 30 against the index pin 60
4 such that sleeve travels to a third position. The third
5 position is illustrated in Figures 3 and 4(c). Fluid has
6 been drawn into the chamber 48 and this drawing and
7 expelling of fluid provides a hydraulic damping effect on
8 the impact on the pin 60. Index pin 60 is now located in
9 an upper apex of the groove 62 and the ports 24,32 are
10 aligned. In this third position fluid is expelled
11 radially from the tool 10 through the now aligned ports
12 24,32. The tool 10 is locked in this position by virtue
13 of the stop 66 on the groove 62 which prevents movement
14 of the sleeve 30 for small variations in fluid pressure.
15
16 In order to close the ports 24,32, a second ball is
17 dropped from the surface through the work string. The
18 second ball, and indeed any ball subsequent to this, is
19 identical to the first ball 68. The second ball will
20 travel to rest in the ball seat 38. On the build up of
21 fluid pressure behind the ball, sleeve 30 will move
22 downwards against the bias of the spring 52. Consequently
23 the index pin 60 will be relocated into the next
24 longitudinal groove 64 of the groove 62 and thus the tool
25 is returned to the second position. When the ball is
26 extruded through the throat 40, the pin 60 and sleeve 30
27 will move relatively back to the first position and the
28 ball will come to rest by the first ball 68. Effectively
29 the tool is reset and by dropping further balls the tool
30 10 can be repeatedly cycled in an open and closed manner
31 as often as desired.
32

1 It will be appreciated that although the description
2 refers to relative positions as being 'above' and
3 'below', the tool of the present invention can equally
4 well be used in horizontal or inclined boreholes and is
5 not restricted to vertical boreholes.

6
7 The principal advantage of the present invention is that
8 it provides a downhole tool for circulating fluid in a
9 borehole which can be repeatedly operated by dropping
10 identical balls through the work string. A further
11 advantage is that the tool can have any number of radial
12 ports to increase the flow area if desired compared with
13 the prior art.

14
15 Further as the ball seat is located above the ports, the
16 ports are opened with no flow going across the seals.
17 This effectively saves the seals from excessive wear. An
18 additional advantage is in the ability of the index
19 sleeve to lock the circulating ports in position when
20 aligned. Yet further the entry and exit of fluid in the
21 chamber for the spring advantageously reduces the impact
22 on the index pin via the hydraulic damping effect.

23
24 Various modifications may be made to the invention herein
25 described without departing from the scope thereof. For
26 example, two or more index pins could be used to provide
27 increased stability to the tool and distribute the load
28 on the pins. Additional radial ports could be located at
29 longitudinal spacings on the tool to provide radial fluid
30 flow across a larger area when the ports are open. The
31 ports may have varying diameters which may provide a
32 nozzle on the outer surface of the body to increase fluid
33 velocity.



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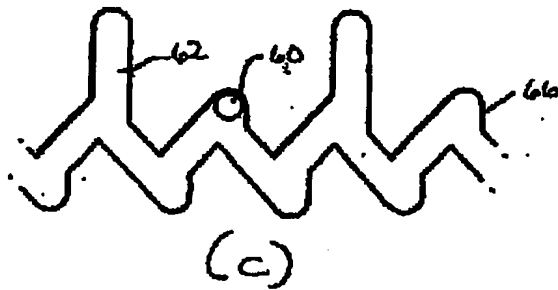
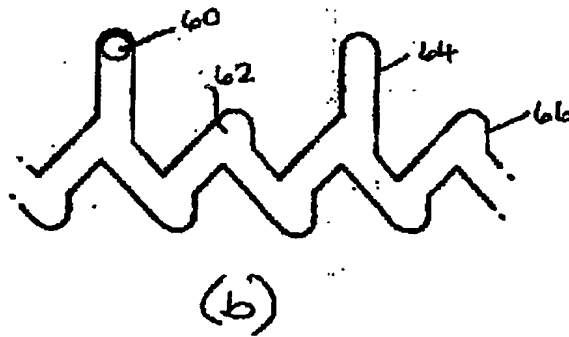
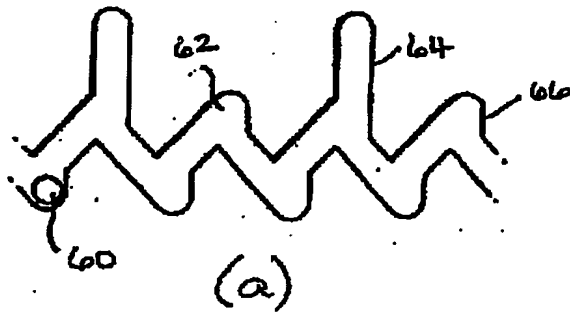


FIG 4

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